INSPECTION AND PROOF OF CANNON.

UNITED STATES NAVY

BUREAU OF ORDNANCE

Gunnery Department.

No............

INSPECTION

AND

PROOF OF CANNON.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1864.

Bureau of Ordnance, *Navy Department, March* 23, 1864.

Sir : The Bureau has the honor to present the accompanying rules and regulations for the "Inspection and Proof of Cannon" for the Navy.

These have been carefully compiled and revised by officers most experienced in ordnance, and are approved by the Bureau. It therefore respectfully submits them for the adoption of the Navy Department.

I am, sir, with high respect, your obedient servant,

H. A. WISE,
Chief of Bureau ad interim.

Honorable Gideon Welles,
Secretary of the Navy.

Navy Department, *Washington, March* 30, 1864.

Sir : The rules and regulations for the "Inspection and Proof of Cannon," submitted with your letter of the 23d instant, are hereby approved, and all officers of the Navy will strictly observe and enforce them.

Very respectfully,

GIDEON WELLES,
Secretary of the Navy.

Commander H. A. Wise,
Chief of Bureau of Ordnance
ad interim, Navy Deparnment.

INSPECTION AND PROOF OF CANNON.

CONTRACTS.

Contracts for guns for the navy shall provide for the uniformity of the mode of their manufacture, as well as of the metal of which they are composed, which should be of the best quality attainable.

To this end, the Chief of the Bureau of Ordnance, when he shall deem it important, may employ some competent person to visit the furnaces from which the iron is to be supplied, and examine the various ores used, for the purpose of selecting the fittest kinds, and determining their proper treatment for making gun-iron.

Experience having shown that certain kinds of metal and general modes of treatment are essential to the production of guns of uniform endurance, these conditions will be insisted on. But as it is also desirable to obtain the experience of the founder, he will be the judge of the particular metal and details of treatment, and will be required to produce a satisfactory trial-gun in case of deviation from established processes.

Before proceeding to execute a contract, a trial-gun may therefore be ordered, at the discretion of the Bureau, subject to the supervision of the resident Inspector, with reference to material and treatment, and to be exposed to extreme proof with service charges.

After undergoing this proof in a manner satisfactory to the Bureau, the trial-gun will serve as a standard, and the proportions of the several kinds of metal used, and the methods employed in its manufacture, must be followed in all respects in the fabrication of the other guns.

A trial-gun may also be ordered by the Bureau, at any time when it may be reasonably suspected that changes have occurred in the quality of the several kinds of metal used at any foundry, as is often the case from the use of different qualities of ores from the same bank, or from the different workings of the same furnace.

But whether a trial-gun has been made or not, a gun may be selected for extreme proof with service charges, by the Chief of the Bureau, out of any lot of guns offered under contract, as an exponent of the whole, to be paid for by the Bureau or not, as may be stipulated in the contract.

Contracts for guns are to comprise the following items, subject to such corrections and additions as may be deemed necessary, from time to time, by the Bureau of Ordnance :

1st. In casting any particular lot of guns, iron from such furnaces, and in such proportions of each grade or number of pig, and such fuel is to be used, as may be decided on at the time by the Bureau, concurrently with the founder.

2d. A proper proving ground is to be provided, and a suitable "butt" and "bomb-proof shelter," when requisite, to be prepared by the contractor, and to be so situated that the firing will not probably be interrupted by an interference of the authorities, the frequent passage of vehicles, or other causes. The "butt" is to be so constructed as to allow the easy recovery of projectiles, and the earth in it to be free from rocks, stones, or gravel; the bomb-proof shelter for the men is to be made safe and convenient of access.

3d. Either two skids or a *proving carriage are to be provided by the contractor for each gun to be fired. If skids be used, they are to be of sufficient thickness to keep the bores of the guns level whilst their trunnions rest on the skids, and their breeches on the ground, and of such length that the guns will not recoil clear of them.

4th. The ground is to be firm enough to prevent difficulty in transporting and handling the guns. The guns are to be placed on the ground, at the expense of the contractor, who should be also required to prevent the exposure of the guns to the weather, and to have them thoroughly cleaned, should they be rusted, before proof.

5th. The labor required in the *proof* will be paid for by the contractor.

6th. The contractor will furnish safe storage for the implements used in proof and inspection, without charge. The storage of powder and projectiles, and the transportation of them to and from magazines, for the proof of guns, will be paid for by the Bureau. also the powder & proj

7th. The manufacture, inspections, and proofs of all the guns contracted for, are to conform in all respects to the conditions prescribed and set forth in the specifications and drawings annexed to and made part of the contract.

8th. The contractor is to afford facilities to the resident Inspector of ordnance for the proper discharge of the duties required of him by these instructions, and by the specific instructions given to him from time to time, by the Chief of the Bureau, in relation to the manufacture, inspection, and proof of guns and projectiles.

9th. No payment is to be made to contractors for guns or projectiles until they shall be delivered, in good order, at the place designated in the contract.

*The proving carriage is a simple frame of oak, with cheeks connected by transoms, which project beyond them sufficiently for the handspikes to take. It has trunnion holes and cap-squares, which afford the means of proving the trunnions, as the carriage is intended to slide on the ground. It presents the further advantage of saving much labor, as does the pendulum in extreme proof. When a proving carriage is used, some means are required readily to mount and dismount the guns. At several of the proving grounds permanent skids are arranged for the proof of cannon. The trunnions rest in a small chock which slides on two of the skids, the breech resting on a third, of such height as to keep the gun level. They are placed at an inclination of about eight degrees, and the gun generally returns to its position for loading after each fire.

INSTRUCTIONS TO INSPECTORS RESIDENT AT FOUNDRIES.

1. The Inspector of Ordnance, resident at a foundry having a contract with or order from the Bureau of Ordnance for the manufacture of guns or projectiles, is expected to attend daily, during working hours, while any part of the work is in progress.

2. He is carefully to examine and note the kinds and qualities of the several lots of materials, including fuel, collected for the manufacture of guns or projectiles for the public service, and to familiarize himself with the various processes employed in making guns and projectiles.

3. He is to keep a journal of his proceedings, and of the occurrences at the foundry or elsewhere connected with the work in hand, noting therein every circumstance likely to be of use for future reference and guidance, and comprising in his remarks as much reliable information as is attainable upon all the points embraced in his specific instructions from the Bureau; and where, in any case, the information obtained is not the result of his own personal observation, he will be careful to note the source from which it is derived.

4. He will also keep a separate and minute account of the materials and manufacture of each gun, in reference especially to the points to which his attention may be called in his instructions, but also comprising, in his general remarks, every point which may suggest itself as important for reference.

5. He will see that each of the several kinds of metal and the fuel used is in itself of uniform quality, and bears the prescribed proportion to the whole charge of the furnace, which charge is to be treated alike in making each gun contracted for.

6. He will keep a careful record, in the prescribed form, of the manner of making moulds, and the materials used in making them; of the character and proportion of each kind and quality of metal of each charge of the furnace; the number of furnaces used; the appearance of the fractures of the pigs; the quantity and quality of the fuel; the state of the atmosphere; the time required to fuse the whole charge, and the time it is kept in fusion before tapping; the temperature of the runners and of the mould; the arrangements for and the time occupied in filling the mould; the mode of heating the pit and flask, and the temperatures thereof at regular intervals; the mode and the time occupied in cooling the casting; the temperature of the flask when hoisted out of the pit, and of the casting when taken out of the flask; and every other particular which may be embraced in the contract or in his instructions, or which may present itself in the course of the operations and tend to secure uniformity and to facilitate comparison.

This record should also embrace, with dates, all the subsequent operations of cutting, turning, boring, chipping, and drilling, and the tests of the metal afforded by each of these processes as to toughness, hardness, soundness, time required, color, as well as the measurement, at various times, the tests of the samples, and the final inspections and proofs; a copy should be left with the foundry for future reference.

7. He is expected, also, to note in his journal any particulars relating to the manufacture of guns or projectiles making at the foundry for other parties, which may be either new or in any manner suggestive of improvement.

He will keep the Bureau advised of the progress of the work, and of all departures from the letter or spirit of the contract; and will, besides, make regular reports, on the last day of each month, of what has been done in the course of it, in the prescribed form, with such additions as circumstances require.

8. He will make timely requisitions on the Bureau or on the nearest navy yard, as directed, subject to the approval of the Bureau, for such ammunition and implements as may be required in the proof of the guns under contract. And he will see that all necessary and proper arrangements are made on the proving ground in due season, and that the guns are properly placed thereon by the contractor; and will notify the Bureau when everything is in readiness for the final inspection and proof, in order that there may be no delay after the order is received at the foundry.

9. He will not show to nor leave in the way of unauthorized persons any plans or drawings, dimensions of guns, or the guns themselves, or any information respecting proofs or experiments in progress, and is to discourage the doing so by the contractors or their agents. This prohibition to form part of the contract as to contractor.

10. As soon as a lot of guns have been inspected and proved, according to the terms of the contract and the instructions of the Bureau of Ordnance, the Inspector will forward his reports thereon, and that on the mechanical tests of the samples, if not previously sent, to the Chief of the Bureau for his decision. In his records and reports he will use the prescribed forms.

11. Guns are not to be received nor marked except with the Foundry numbers on the cascabel, nor are any bills for them to be approved by the Inspector until he shall have received authority to that effect from the Bureau.

12. A certificate, in the form following, is always to accompany the bill of charges for expenses incurred by the contractor in proving guns, viz:

——— FOUNDRY, ———, 18 .

I hereby certify that the materials charged in the foregoing bill have been used, and the authorized expenses charged therein incurred, in proving ——— guns made under contract with the Bureau of Ordnance, by ——— ———.

——— ———

Inspector of Ordnance.

13. The bills must be made out in *triplicate*, and approved by the Chief of the Bureau, before they can be paid by the navy agent.

After inspection, the *bores* of guns are to be oiled with fish oil. Oiling the outside would prevent their being readily handled.

FORM OF RECORD TO BE KEPT BY THE RESIDENT INSPECTOR AT THE FOUNDRY FOR EACH GUN CAST.

Calibre and class, ——. *Foundry, No.* —. *Weight in pounds*, ——. *Date when cast*, ——.

Metal. (Information to be obtained in relation to the furnaces, ores, and fuel used in smelting must be obtained from the founder, unless officers are sent to the furnaces.)	From what ores, and the situation of ore beds. From what furnace received. Kind of fuel used in making the pig iron. Cold, hot, or warm blast used in making it. General character and appearance of the pig iron, as respects color, texture, and fracture.
Weight of metal composing charge of furnace.	Weight of different kinds of pig iron used from different ores and furnaces for this gun. Weight used of different fusions of each kind of iron. Total weight of metal for charge of furnace.
Relating to the process of manufacture and cooling.	Kind of furnace. Mode of preparing the hearth. How many furnaces are used in melting iron for any one gun, and how do their streams mingle before entering the mould. Kind of fuel used. Mode of firing. Time required to obtain complete fusion. Taking out specimens during the progress of melting. Time kept in fusion. How introduced into the mould of the gun. What precautions are taken to prevent scoria entering the trunnions. Time employed in filling the mould. Dimensions of gun-head and nature of shrinkage Arrangements for retarding the cooling. Length of time the gun is left in pit for cooling. Excess in the diameter in any part of the casting beyond the prescribed dimensions of the gun. Temperature of mould, } at the time of casting, and after being opened, and Temperature of pit, } when the gun is hoisted out. Position of the thermometer in the pit. Temperature of the pit, and of the external air, at 8 a. m. and 4 p. m. daily, during the time the gun is left in the pit for cooling. Temperature of the air, and gun when it is detached from the mould. Under the head of general remarks, any facts which may seem to the inspector worthy of record.

Qualities of the metal:

- External imperfections, if any, of the gun when cleaned.
- How does the metal work under the tools, hard, soft, or otherwise?
- Is it tenacious or brittle?
- Time occupied in boring the gun.
- Time occupied in turning the gun.
- Appearance of the bore, perfect or otherwise.
- Appearance of surface after being brought down to true dimensions.
- Appearance of core, sound or otherwise.
- Appearance of core-metal at places of fracture.
- Tenacity and density of specimens from gun-heads.
- Tenacity and density of specimens from core taken between muzzle and trunnions.
- Tenacity and density of specimens from nearly opposite to trunnions.
- Tenacity and density of specimens from near the bottom of bore.
- Any apparent causes for doubting the good qualities and strength of the gun.
- Any other useful information.

The Resident Inspector shall take accurate measurements of the different parts of the guns as soon as they are finished. These examinations are for the information of all the parties, but are not to be considered as decisive for reception.

As soon as the casting has been completed the information shall be collected and forwarded to the Bureau of Ordnance, according to the form now in use, or that which shall be from time to time prescribed.

The manufacture of rifled cannon and projectiles being consided as yet only experimental, specific directions relative to their manufacture, inspection, and proof, will be given from time to time as requisite.

TENACITY AND DENSITY OF IRON.

Tho Resident Inspecting Officer will subject the motal of each gun to the usual tests of tenacity and density, and for this purpose will take samples from the sinking head, the core, or such other available parts of tho casting, and in such manner as may be prescribed, and will forward duplicato specimens to the Ordnance Yard at Washington for trial.

The axis of tho sample is to be parallel to or at right angles with the axis of the casting, as may be required by the Bureau. Fairly to represent the metal of the gun, the samples from the head should not be taken from tho part opposite the boro, but opposite to the middle of tho thickness of the metal remaining in the gun after being bored and turned. The mass from which the sample is taken, whether sinking head or core, must have tho same foundry number cast or stamped upon it as the gun to which it belongs, beforo being taken away from the gun. Each sample must have the foundry number of the casting it represents ; and an initial letter and a number, designating the part of the gun or gun-head from which it was takon, and its distanco from the axis of tho bore, and from tho baso line, stamped upon both its ends. To provent confusion, the samples should be marked on one end before they are disconnected from the mass, and should not be separated from it, except in the presence of the inspecting officer.

When practicable, the tests are to be made at tho foundry, before the guns are subjocted to proof. They aro to be carefully made, and duly recorded and reported to the Bureau with tho other proofs and inspections, that they may afford means of comparison between the metal of different foundries and guns.

No particular value is attached to these tests as an indication of the endurance of tho gun, but only as oxhibiting the similarity that the several guns bear to tho standard gun. Experienco has shown that a variation of 2,250 pounds, moro or less, in the tensile strength, is a sufficient limit to be allowed, and within which to confine the founders; an exact adherence being impossiblo.

THE INSTRUMENTS employed in TESTING METALS are as follows :

THE TESTING MACHINE, (devised by Major W. Wade,) complete with the implements for determining the resistance offered by various kinds of metal to tensile, torsional, transverse, bursting, crushing, and indenting forces.

THE HYDROMETER, (constructed on the principlo of Nicholson's, and improved by Wado,) complete with implomonts and adjusting weight for the determination of the density of samples.

Tho elaborate "Reports of Experiments on tho Strength and other Properties of Metal for Cannon," published in 1856, by authority of the Secretary of War, contains full descriptions of these instruments, and their implements, with plates. A copy of this work will be furnished for tho use of the inspecting officer at each of the foundries.

WURDEMAN'S DENSIMETER, or balance for specific gravities.

DETERMINATION OF DENSITY AND TENACITY.

DENSITY.

To determine the density, the sample is weighed in air, and in pure distilled water. Clear rain or river water may be substituted, if its relative density be first accurately determined. The hydrometer may be employed for this purpose, and the proper correction applied.

The weight of the hydrometer, together with its balance weight in distilled water, determines the weight of a quantity of standard water equal in bulk to the immersed part of the instrument.

The weight of the hydrometer and its load, when immersed in like manner, in any other water at the same temperature, determines the weight of a corresponding bulk of the latter; and this weight, divided by the former, gives the multiplier for correcting the density, when ascertained in any other than distilled water.

At the foundries, generally, river water is found to be sufficiently pure for use, without requiring any correction.

In determining the density of samples, first load the weight-dish with the grain weights, until the hydrometer is immersed to its zero mark, and then record the sum of the weights in the dish as the *balance of the hydrometer*. Next remove the weights, and place the sample in the dish with as many weights as will bring the hydrometer again to its zero point, and record the sum of these weights as the balance with the *sample in air*. The difference between these balances is the weight of the sample in air. Then place the sample on the bulb, and immerse both, until the hydrometer is again adjusted to its zero, and then record the weights employed in this adjustment as the *balance with the sample in water*. The difference between this balance and that given by the samplo in air is the weight of water displaced by the immersed sample. In this operation, care must be taken to remove any air bubbles, which is facilitated by first wetting the specimen.

The temperature of the water at the time of weighing the immersed sample is observed and noted by means of a thermometer suspended in it. If it is not at 60°, the weight of water displaced by the sample is divided by the tabular number opposite the noted temperature, and the quotient gives the corrected displacement. Tho weight of tho sample in air, divided by the corrected displacement, gives the density of the sample.

EXAMPLE.

Sample No. 4 H, from gun head:

Balance of the hydrometer	11485.0
Balance with sample in air	923.0
Difference = weight of sample in air	10562.0

Balance with sample in water	2370.4
Balance with sample in air	923.0
Difference = weight of water displaced: noted temperature, $72\frac{1}{4}°$	1447.4

Tabular number $72\frac{1}{4} = .998912$

Then $\dfrac{1447.4}{.998912} = 1449.0 =$ corrected displacement.

And $\dfrac{10562}{1449} = 7.289 =$ density.

Or by logarithms:

	Logarithms.
Water displaced at $72\frac{1}{4}° = 1447.4$	3.1605886
Tabular number for $72\frac{1}{4}° = .998912$	$\bar{1}.9995274$
Logarithm of corrected displacement	3.1610612
Weight of sample in air = 10562	4.0237461
Corrected displacement	3.1610612
Density = 7.289 =	0.8626849

If impure water has been used, correct the ascertained density by the rule given in the last paragraph.

The determination of densities by the hydrometer, (or hydrostatic balance,) although theoretically exact, requires much practice to arrive at correct results, and is moreover very tedious.

The densimeter, or balance, may therefore be advantageously substituted for it, the results being occasionally checked by the hydrometer.

In appendix –

Weights of distilled water displaced by the same glass bulb at different temperatures, compiled by W. Wade from Hassler's report on weights and measures.

Temperature, Fahr.	Weight of water reduced to an unit.	Logarithms of weights.	Temperature, Fahr.	Weight of water reduced to an unit.	Logarithms of weights.	Temperature, Fahr.	Weight of water reduced to an unit.	Logarithms of weights.
32°.00	1.000395	0.0001706	45°.00	1.000621	0.0002699	58°.00	1.000133	0.0000579
.25	406	.0001764	.25	619	.0002687	.25	118	.0000512
.50	420	.0001825	.50	616	.0002675	.50	101	.0000439
.75	433	.0001880	.75	613	.0002660	.75	085	.0000368
33.00	444	.0001928	46.00	610	.0002646	59.00	068	.0000296
.25	455	.0001975	.25	606	.0002631	.25	051	.0000222
.50	467	.0002028	.50	602	.0002615	.50	034	.0000149
.75	479	.0002078	.75	598	.0002598	.75	017	.0000072
34.00	489	.0002123	47.00	594	.0002578	60.00	1.000000	0.0000000
.25	499	.0002167	.25	589	.0002558	.25	0.999981	$\bar{1}$.9999919
.50	510	.0002214	.50	584	.0002537	.50	963	.9999839
.75	519	.0002253	.75	579	.0002515	.75	945	.9999760
35.00	527	.0002288	48.00	574	.0002493	61.00	927	.9999681
.25	536	.0002329	.25	569	.0002470	.25	909	.9999603
.50	545	.0002366	.50	564	.0002448	.50	890	.9999522
.75	553	.0002401	.75	558	.0002421	.75	871	.9999440
36.00	560	.0002432	49.00	551	.0002393	62.00	853	.9999361
.25	566	.0002459	.25	545	.0002366	.25	834	.9999280
.50	572	.0002483	.50	538	.0002336	.50	814	.9999193
.75	577	.0002504	.75	531	.0002306	.75	795	.9999108
37.00	581	.0002523	50.00	524	.0002276	63.00	774	.9999020
.25	586	.0002542	.25	517	.0002244	.25	753	.9998929
.50	589	.0002561	.50	508	.0002207	.50	733	.9998840
.75	595	.0002581	.75	499	.0002168	.75	712	.9998747
38.00	599	.0002603	51.00	490	.0002130	64.00	692	.9998660
.25	604	.0002622	.25	482	.0002191	.25	672	.9998574
.50	609	.0002642	.50	472	.0002050	.50	651	.9998483
.75	614	.0002666	.75	462	.0002007	.75	629	.9998388
39.00	619	.0002685	52.00	452	.0001961	65.00	608	.9998294
.25	628	.0002725	.25	441	.0001915	.25	585	.9998198
.50	635	.0002755	.50	430	.0001869	.50	563	.9998104
.75	642	.0002786	.75	419	.0001821	.75	542	.9998011
40.00	646	.0002806	53.00	409	.0001775	66.00	521	.9997918
.25	649	.0002817	.25	398	.0001727	.25	499	.9997822
.50	650	.0002821	.50	387	.0001679	.50	479	.9997737
.75	650	.0002821	.75	374	.0001625	.75	454	.9997630
41.00	649	.0002819	54.00	363	.0001574	67.00	432	.9997533
.25	649	.0002815	.25	349	.0001515	.25	409	.9997435
.50	647	.0002810	.50	337	.0001465	.50	387	.9997338
.75	645	.0002802	.75	322	.0001398	.75	365	.9997243
42.00	644	.0002796	55.00	307	.0001348	68.00	343	.9997146
.25	643	.0002792	.25	296	.0001286	.25	320	.9997047
.50	642	.0002787	.50	282	.0001223	.50	297	.9996945
.75	641	.0002781	.75	267	.0001161	.75	273	.9996843
43.00	639	.0002774	56.00	254	.0001103	69.00	249	.9996740
.25	637	.0002766	.25	239	.0001040	.25	226	.9996636
.50	635	.0002756	.50	224	.0000973	.50	202	.9996532
.75	633	.0002748	.75	209	.0000910	.75	178	.9996427
44.00	631	.0002740	57.00	195	.0000846	70.00	153	.9996320
.25	629	.0002731	.25	181	.0000783	.25	127	.9996208
.50	626	.0002721	.50	165	.0000717	.50	102	.9996098
.75	1.000624	0.0002710	.75	1.000148	0.0000644	.75	0.999076	$\bar{1}$.9995985

Weights of distilled water displaced by the same glass bulb at different temperatures, &c.—Continued.

Temperature, Fahr.	Weight of water reduced to an unit.	Logarithms of weights.	Temperature, Fahr.	Weight of water reduced to an unit.	Logarithms of weights.	Temperature, Fahr.	Weight of water reduced to an unit.	Logarithms of weights.
°			°			°		
71.00	0.999050	$\bar{1}.9995873$	76.25	0.998430	$\bar{1}.9993175$	81.50	0.997754	$\bar{1}.9990233$
.25	024	.9995759	.50	399	.9993039	.75	718	.9990079
.50	0.998997	.9995642	.75	367	.9992904	82.00	681	.9989918
.75	969	.9995522	77.00	337	.9992771	.25	644	.9989756
72.00	942	.9995401	.25	309	.9992649	.50	607	.9989596
.25	912	.9995274	.50	278	.9992515	.75	571	.9989438
.50	884	.9995150	.75	248	.9992382	83.00	536	.9989286
.75	855	.9995027	78.00	216	.9992244	.25	500	.9989138
73.00	825	.9994892	.25	184	.9992104	.50	468	.9988989
.25	795	.9994765	.50	152	.9991965	.75	433	.9988837
.50	766	.9994635	.75	120	.9991826	84.00	398	.9988684
.75	736	.9994506	79.00	088	.9991686	.25	363	.9988532
74.00	705	.9994373	.25	055	.9991545	.50	327	.9988378
.25	675	.9994241	.50	022	.9991400	.75	292	.9988223
.50	645	.9994113	.75	0.997989	.9991258	85.00	256	.9988068
.75	615	.9993979	80.00	956	.9991113	.25	220	.9987908
75.00	584	.9993845	.25	923	.9990970	.50	183	.9987750
.25	553	.9993710	.50	889	.9990822	.75	150	.9987604
.50	521	.9993574	.75	855	.9990673	86.00	0.997116	$\bar{1}.9987456$
.75	492	.9993446	81.00	821	.9990526			
76.00	0.998461	$\bar{1}.9993313$	.25	0.997788	$\bar{1}.9990383$			

To make the corrections for the weight of water displaced when the body is weighed at any other temperature than 60°, divide the ascertained displacement by that number in the table which corresponds with the noted temperature, and the quotient will be the weight of water which the same body would have displaced in the same water if weighed at the temperature of 60°. Or by logarithms, subtract the logarithm opposite the noted temperature from the ascertained logarithm of displacement, and the remainder will be the logarithm of the corrected displacement. The volume of the body weighed changes with variations of temperature, and this will cause a slight error when the weighings are made at extremes of temperature. But as the difference between the dilatation by heat of the glass bulb and cast-iron cannot be measured, error from this cause may be neglected.

The temperature of 60° Fahrenheit has been taken as the unit, because that is about the medium temperature which occurs in ordinary practice.

WURDEMAN'S DENSIMETER, OR BALANCE FOR SPECIFIC GRAVITIES.

DESCRIPTION.

The balance for the determination of specific gravities is in principle a simple beam scale of accurate workmanship.

As made by Wurdeman, it consists of an open beam of German silver, twelve and nine tenths ($12\frac{9}{10}$) inches in length between the knife edges; one and three fourths ($1\frac{3}{4}$) inches in width at the centre; three fourths ($\frac{3}{4}$) of an inch at the extremities of the beam; and two tenths ($\frac{2}{10}$) of an inch in thickness.

From the extremities of the beam the scale pans are suspended on knife edges.

The knife edge, in the centre of the beam, is one and four tenths ($1\frac{4}{10}$) inches long; those at the extremities nine tenths ($\frac{9}{10}$) of an inch; all bearing their lengths on steel plates, which are preferable to stones, as the latter are seldom of sufficient uniformity in texture to give, in cutting and polishing a perfectly plain surface.

The beam is supported on a hollow column, through which a rod passes for lifting the beam, which, when not in use, rests on its Y's on a cross-bar at the top of the column; this bar also supports the scale pans on separate rests, free from contact with the knife edges.

The column is set on a brass plate, furnished with a circular spirit level and foot screws for accurately levelling it.

The whole apparatus is enclosed in a glass case, to protect it from dust or currents of air, with a sliding front, which is counterpoised for convenient manipulation.

ADJUSTMENTS.

The beam is balanced by two adjustments placed above it: Firstly, by the horizontal screws, with milled heads, for the zero of the index below; and, secondly, by the large nut on the perpendicular screw for vertical balance. This last, when once set, it is seldom necessary to touch.

To adjust the arms to equal length: There is to each knife-edge end a steel screw, with capstan head, which, when screwed forward, will spring out the part on which the knife edge rests, and thus lengthen its distance from the centre. Both ends are made thus adjustable, by which means perfect symmetry of the two parts of the beam is obtained, and the necessity of screwing back during the adjustment is obviated, since it will merely be necessary to lengthen the arm which proves to be shortest.

To test this, the relative place of the scales should be changed after first balancing them exactly; if, after the change, either preponderates, it proves that arm to be the longest. One half the difference is to be corrected with weights, and the other half with the adjusting screws. Great caution must, however, be observed in not screwing up too much at a time.

A correct result in weighing may be obtained without this adjustment being absolutely exact, by first balancing the specimen to be weighed with any convenient substance, then removing the specimen and substituting in its place known weights until equilibrium with the counterpoise is restored.

Which works the steadying pin, w under each lever.

USE OF THE INSTRUMENT.

By a crank placed in front of the case, the centre bearing is gently raised, which, lifting the beam off its Y's, also takes up the scales.

When the beam is completely raised, the oscillations of the scales are arrested by touching the spring lever on the right of the crank. On abandoning the lever the preponderance of the specimen, or the weight, will immediately be manifested, and additional weights may be added or removed until they are in equilibrium.

When placing the specimen and estimated counterbalancing weights in the scales, the beam should always be let down on the supports; but small weights may be added or changed whilst simply arresting the scales with the lever.

The door should not be pushed up higher than is just necessary to obtain convenient access.

As the balance is very sensitive, care should be taken not to abrade the pans by carelessly putting in the specimens, or rubbing to remove dust.

DETERMINATION OF SPECIFIC GRAVITY.

For the determination of specific gravities a German silver vessel is used, just large enough to conveniently hold the specimen, and open at the top, which is planed off perfectly straight, so that a plate-glass, provided for the purpose, can be slid over it, and will shut air-tight. This vessel is filled with distilled water, carefully removing air bubbles from inside the vessel, or drops mechanically adhering to the outside. Weight and temperature are noted, and a table may be computed, so that this element constitutes, for the instrument used, a constant. It will be convenient to keep the water in a reservoir of considerable size, to avoid the inconvenience of frequent changes of temperature.

The absolute weight of the specimen having been previously taken and noted, the specimen is then submerged in the vessel, and displaces a quantity of water equal to its volume. The vessel is again covered with the plate-glass, using the same precautions as above, and the weight is taken.

Since specific gravity is represented by the ratio of the absolute weights of the same volume of water, and of the article to be determined, we have to divide the weight of specimen by a quantity obtained, by deducting the weight of the vessel, with specimen inserted, from the sum of weight of vessel filled with water, and of the weight of specimen.

Therefore, if

C = Weight of vessel filled with water (constant);
W = Absolute weight of specimen;
W_1 = Weight of vessel with specimen submerged;
S = Specific gravity;

We have—

$$S=\frac{W}{C+W-W_1}$$

FORM OF RECORD OF COMPUTATION,

Fort Pitt Foundry,

BY DENSIMETER.

Calibre.	No.	Spec.	Temp.	Weight.	Grains.	Grains.	Temp.	Log.	Sp. Gr.
IX-inch shell gun ..	1910	H. 1	63°	Tank filled....... Spec. in air	8962. 1 9845. 5	18807. 6	63°	$\bar{1}$. 9999020 3. 9932378	
				Spec. in water.... Water displaced ..	....	17465. 0 1342. 6	......	3. 9931398 3. 1279466	
								. 8651932	7. 332
IX-inch..........	1910	H. 2	63°		8962. 1 9787. 2	18749. 3	63°	$\bar{1}$. 9999020 3. 9906585	
				Water displaced ..	....	17416. 5 1332. 8	......	3. 9905605 3. 1247650	
								. 8657955	7. 342
IX-inch..........	1910	H. 3	63°		8962. 1 9899. 6	18861. 7	63°	$\bar{1}$. 9999020 3. 9956176	
				Water displaced ..	....	17513. 5 1348. 2	......	3. 9955196 3. 1297543	
								. 8657653	7. 341
IX-inch shell gun ..	1912	H. 1	63°		8962. 1 9872. 5	18834. 6	63°	$\bar{1}$. 9999020 3. 9944271	
				Water displaced ..	....	17487. 2 1347. 4	......	3. 9943291 3. 1294965	
								. 8648326	7. 325
IX-inch..........	1912	H. 2	63°		8962. 1 9846. 6	18808. 7	63°	$\bar{1}$. 9999020 3. 9932863	
				Water displaced ..	....	17467. 3 1341. 4	......	3. 9931883 3. 1275583	
								. 8656300	7. 339
IX-inch..........	1912	H. 3	63°		8962. 1 9724. 0	18686. 1	63°	$\bar{1}$. 9999020 3. 9878450	
				Water displaced ..	....	17361. 3 1324. 8	....	3. 9877470 3. 1221503	
								. 8655967	7. 338

FORM OF

Report of the density and tensile strength of the specimens taken

Calibre.	Foundry mark.	Specimen.	Temp. tank.	Density by densimeter.	Temp. hydro.	Density by hydro.	Diff. of temp.
IX-inch shell gun................	No. 1910	H. 1	63°	7. 332	64°	7. 330	1°
	1910	H. 2	63°	7. 342	....	7. 341	
	1910	H. 3	63°	7. 341	....	7. 340	
IX-inch shell gun................	No. 1912	H. 1	63°	7. 325	64°	7. 324	1°
	1912	H. 2	63°	7. 339	....	7. 338	
	1912	H. 3	63°	7. 338	....	7. 340	

ORDNANCE-YARD, WASHINGTON.

November 19, 1863.

BY HYDROMETER.

Calibre.	No.	Spec.	Temp.	Weight.	Grains.	Grains.		Log.	Sp. Gr.
IX-inch shell gun...	1910	H. 1	64°	Bal. of hyd ...... Bal. with spec. in air	12784. 2 2938. 5	9845. 7	64°	$\bar{1}$. 9998660 3. 9932466	
				Spec. in water .... Water displaced ..	4281. 3	1342. 8	......	3. 9931126 3. 1280113	
								. 8651013	7. 330
IX-inch...........	1910	H. 2	64°		12784. 2 2996. 7	9787. 5	64°	$\bar{1}$. 9998660 3. 9906718	
				Water displaced ..	4329. 6	1332. 9	......	3. 9905378 3. 1247976	
								. 8657402	7. 341
IX-inch...........	1910	H. 3	64°		12784. 2 2884. 7	9899. 5	64°	$\bar{1}$. 9998660 3. 9956133	
				Water displaced ..	4232. 9	1348. 2	......	3. 9954793 3. 1297543	
								. 8657250	7. 340
IX-inch...........	1912	H. 1	64°		12784. 2 2911. 8	9872. 4	64°	$\bar{1}$. 9998660 3. 9944227	
				Water displaced ..	4259. 4	1347. 6	......	3. 9942887 3. 1295610	
								. 8647277	7. 324
IX-inch...........	1912	H. 2	64°		12784. 2 2937. 8	9846. 4	64°	$\bar{1}$. 9998660 3. 9932775	
				Water displaced ..	4279. 2	1341. 4	......	3. 9931435 3. 1275583	
								. 8655852	7. 338
IX-inch...........	1912	H. 3	64°		12784. 2 3060. 2	9724. 0	64°	$\bar{1}$. 9998660 3. 9878450	
				Water displaced ..	4384. 6	1324. 4	......	3. 9877110 3. 1220192	
								. 8656918	7. 340

REPORT.

from the following cannon, Fort Pitt Foundry, Pittsburg, Pa.

Actual density.	Mean density.	Diam. of specimen.	Breaking weight.	Tensile strength.	Mean tens. str.	Date, when received, &c.
			Pounds.	*Pounds.*		
7. 331 7. 342 7. 341	7. 338	1. 20	38000 39000 39000	33600 34480 34480	34187	Received November 19, 1863.
7. 325 7. 339 7. 339	7. 334	1. 20	37700 37800 38000	33330 33420 33600	33450	Broken November 24, 1863.

TENACITY.

After the density is ascertained, and before the sample is inserted in the pincers for the tensile test, its smallest diameter in the middle is accurately measured by the specimen calipers, and recorded. The breaking weight is divided by the area of its smallest diameter, and the quotient gives the tenacity, or the strength per square inch.

In order to obtain reliable comparative results, it is necessary that the specimens shall all conform to the standard in size and shape;

The breaking strain be applied slowly and gradually;

That the specimen be placed fairly in the clamps, so that it is not subjected to a strain of torsion with that of extension.

EXAMPLE.

Sample No. 4 H, from gun head:

	Logarithms.
Breaking weight, 50500	4.7032914
Diameter, 1.25. Area, 1.22719	0 0889099
Tenacity, or strength per square inch, 41151 pounds	4.6143815

The following table contains the areas and the logarithms for all the variations of diameter likely to occur in tensilo samples:

Diam.	Area.	Logarithms.	Diam.	Area.	Logarithms.	Diam.	Area.	Logarithms.
1.190	1.11220	.0461839	1.204	1.13853	.0563429	1.297	1.32120	.1209698
1.191	1.11407	.0469135	1.205	1.14042	.0570639	1.298	1.32324	.1216393
1.192	1.11594	.0476425	1.206	1.14231	.0577845	1.299	1.32528	.1223083
1.193	1.11782	.0483707	1.207	1.14421	.0585045	1.300	1.32732	.1229767
1.194	1.11969	.0490985	1.208	1.14610	.0592237	1.301	1.32937	.1236446
1.195	1.12157	.0498257	1.209	1.14800	.0599425	1.302	1.33141	.1243120
1.196	1.12345	.0505523	1.210	1.14990	.0606607	1.303	1.33346	.1249788
1.197	1.12533	.0512783	1.290	1.30698	.1162693	1.304	1.33550	.1256451
1.198	1.12721	.0520035	1.291	1.30901	.1169423	1.305	1.33755	.1263109
1.199	1.12909	.0527283	1.292	1.31104	.1176148	1.306	1.33960	.1269763
1.200	1.13097	.0534523	1.293	1.31307	.1182868	1.307	1.34165	.1276411
1.201	1.13286	.0541759	1.294	1.31510	.1189583	1.308	1.34370	.1283033
1.202	1.13475	.0548989	1.295	1.31713	.1196293	1.309	1.34576	.1289691
1.203	1.13664	.0556211	1.296	1.31917	.1202998	1.310	1.34782	.1296325

INSPECTIONS OF NEW GUNS.

New guns are to be closely examined and measured, inside and out, for defects of metal or manufacture, and the results recorded in the prescribed forms by the Inspector resident at the foundry, as soon after being finished as possible, if he has not already done so in the various stages of manufacture, which is preferable, as the detection of errors which pass the limits of toleration may save useless subsequent labor. Internal defects of metal will, for instance, generally be betrayed by a close examination of the core pieces. As rust tends to conceal defects, this examination of the guns is to take place before exposure to the weather. And previously to the final examination and proof of guns, they are not to be covered with paint, lacquer, oil, or any material which may hide defects of metal.

If it is ascertained that any attempt has been made to conceal defects, the gun or guns so treated are to be rejected without further examination.

As the water-proof, which is of great importance in detecting defects of metal not otherwise developed, necessarily succeeds immediately the powder-proof, and can be effectively applied only in fine weather and when the temperature is above the freezing point, final inspections are to be made at such times only.

DESCRIPTIVE LIST OF INSTRUMENTS REQUIRED AND USED IN THE INSPECTION AND PROOF OF GUNS.

1st. A mirror for reflecting the sun's rays into the bores. Two will be required if the sun be in rear of the inspector.

2d. A lamp attached to a staff for examining the bores when the sun is obscured, or the guns are under cover.

3d. A standard cylinder gauge. This is a hollow cylinder of iron, turned to the least allowed diameter of the bore, and one calibre in length. It has a cross-head at each end, one of which has a smooth hole through its axis to fit the staff, and the other is tapped to receive the screw in the end of it.

4th. A measuring staff of steel or iron, in joints of suitable length, which are connected together by screws. Each joint is provided with a light brass *disc*, the diameter of which is 0.05 inch less than that of the bore. Through the centre of the disc there is a hole which fits upon a shoulder at the joint; the whole is so arranged that when the joints are screwed together the discs between them are held firmly in place, while the length of the staff is not affected by them. A *steel point is* screwed on to the end. When pushed to the bottom of the bore, the staff coincides very nearly with its axis. The outer joint is graduated to inches and tenths. A *slide* is made to play upon it with a vernier scale, graduated to hundredths of an inch. On the inner end of the slide a branch projects at a right angle, sufficiently long to reach across the muzzle face, and when in contact with it to indicate the precise length obtained from that point to the end of the measuring point on the other end of the staff. A half disc of wood, made to fit the bore, with a groove for the staff to rest in, placed just inside of the muzzle, is useful in preventing any springing of the staff.

The point being taken off, the staff can be used with the cylinder gauge to measure the distance to which the latter descends. But as the graduation is intended for the points, care must be taken in this case to allow for the difference.

5th. *A chamber gauge* for verifying the shape and size of conical chambers.

The head should be made of close-grained, well-seasoned wood, and of the exact dimensions of the chamber. Two planes crossing each other at a right angle, coinciding with the vertical and horizontal central sections, have been found better than a solid block. The edges should be bevelled. A metal socket in its centre connects it with the measuring staff. Being pushed to the bottom of the bore, if the length coincides with that obtained by the point, it is obvious that the chamber is large enough, provided the cylindrical part has not been bored too deep, in which case a shoulder would be found at the junction. The edges of the gauge should be chalked before it is inserted. When withdrawn, if the chalk marks are visible all around the chamber, it is evident that the chamber is not too large. With slight modifications, this arrangement may be applied to the slope of cylindrical chambers, and to the curve at the bottom of the bore of any guns. Should the inspection of guns with conical chambers or slopes take place at the foundry, an examination of the chamber reamer will be very satisfactory. If found correct in size and shape, the impossibility of making the chamber *too large* will be apparent.

6th. *A star gauge*, for measuring the diameters of the bores and of cylindrical chambers. This instrument is composed of *the staff*, *the handle* and a *set of points* for each calibre.

The staff is a brass tube, made in three pieces, for convenience of stowage, and connected together, when required, by screws. Its inner end expands into a head, in which are placed four steel sockets, at equal distances from each other, which receive the points. Two of the sockets opposite to each other are secured permanently. The two others are movable. A tapering plate or wedge, the sides of which are cylindrical, runs through a slit in the head; an aperture in the inner ends of the movable socket embraces the cylinder, so that when the plate is moved forward or backward, the sockets are projected or withdrawn. The tapering of the plate has a certain known proportion to its length, so that if it is moved in either direction a given distance, a proportional movement is imparted to the sockets, and to the points which they contain. It is easy to see how, in this manner, a movement of .10 in. may increase or diminish the distance between the points .01 in. Therefore there would be no difficulty in estimating, to a considerable degree of accuracy, a difference of .001 in. between the points. In general, however, the distance on the plate required to move the points .01 in. is about .06 in. only.

A square sliding-rod is connected with the tapering-plate, and runs through the whole length of the tube, projecting some inches beyond the outer end. This rod has as many parts as there are joints in the staff, and, like them, connects by screws. Each section of the rod works in its proper joint, through a square socket at each end, and is prevented from falling out by pins. When screwing the joints together, if the ends of the rod are pressed up to each other they become connected by the same motion.

The staff is graduated to inches and quarters, so that the distance of the points from the muzzle of the gun may always be known. A centre line, starting from the centre of the upper socket, is marked upon the staff throughout its length.

The handle in use at present is of brass, made to fit over the outer end of the staff, and to connect with the sliding-rod by a screw, having a large milled head at the outer extremity of the handle. It may be used on either joint, as required. A slit through the handle permits a part of the staff near the end to be seen beneath. A scale on one side of the slit is graduated with the distance that the rod moves, to throw the points .01 in. apart.

That part of the handle containing the slit and scale is separated from the other part; it is made to fit closely over it. On each side there is a small tube; a thread is cut in one, through which a fine screw, held by a stud on the permanent part of the handle, works and gives it motion; a guide runs through the other. Seen through the slit is a small plate of silver inserted in the staff, and a fine mark upon it to show the place of zero, when the points are adjusted. The zero mark on the scale is made to correspond with it by means of the screw just mentioned.

The points are of steel, with a strong shoulder at one end, below which the screw is cut that fits into the socket in the head. A wrench is made to fit the other end so as to turn the point firmly into its place. They are made of such a length that they will just pass into the adjusting ring when they are all in place. To this instrument belong the adjusting *rings* and the *muzzle rest* in the form of T; of the rings there is one for each calibre, reamed out to the exact minimum diameter of the bore. The latter can be used for any class of guns. Its office is to keep the staff of the star gauge in the axis of the bore. For this purpose it contains a groove, above the perpendicular branch, to receive the lower half of the staff. There is a movable slide on each branch, which can be adjusted to marks for each calibre, so that points projecting from their rear will enter the muzzle and hold the rest in place. In this position the upper edge of the transverse branch coincides with the diameter of the bore.

A hook is pivoted on the inner side of the transverse branch, on one side of the groove, and so fitted that when the star gauge is in the gun, it embraces one-half of that portion of the staff which is above the groove. Therefore, if the transverse branch be placed so as to coincide with the axis of the trunnions, the hook thrown over the staff, and the latter turned so that the centre line just meets the end of the hook, the perpendicular points will be perpendicular to the axis of the trunnions. If the staff is then drawn out carefully, the measurements will all be taken in the same plane. A notch in the end of the hook, made to coincide with the plane of the muzzle, may be used for marking the distances on the staff.

The upright branch is movable, and is made to fit into the end of the transverse branch for convenience and security in packing.

In examining the bores after proof, it has been found that the greatest indentation occurs in general near the seat of the projectiles. But as it is not always found at precisely the same point of the circle of the bore, a convenient mode of searching for it is desirable. This is

supplied by a *disc for circular measurements*, which may also be considered as belonging to the star gauge. It is made of composition, and is divided into halves, with a hole through the centre to receive the staff of the star gauge.

It is turned so as to fit into the muzzle of the gun closely, with a projecting lip two or three inches broad to hold it in place, and with cleats overlapping the edges, to keep it from going in too far. The face is a plane surface. The circumference is divided into as many equal parts as may be thought desirable, which are numbered in regular order. The centre hole is reinforced on the inside by a projection which is turned to receive a collar that fits closely around it, and holds the two halves together when they are placed on the staff.

When ready for use, the face is in the plane of the muzzle face. Its zero mark is made to coincide with a light punch mark on the muzzle face, directly below the line of sight.

On the staff of the star gauge a *brass slide* is fitted, having a thumb-screw to hold it in any position; from the inner end a point extends at a right angle to its axis, of sufficient length to meet the points at the circumference of the disc; a centre line extends from the base to the apex. The slide being moved so as to make its inner end coincide with any mark upon the staff, at which a circular measurement is required, and the centre line of the point being made to coincide with that of the staff, it is secured by the thumb-screw. The point of the slide is then in the same plane with the perpendicular measuring points, and its direction always indicates theirs; a series of measurements made before proof may thus be compared with another made at the same points after proof.

It is obvious that the determinations will not be absolutely accurate, for when the gun is worn, should the stationary points be perpendicular, the movable points being then horizontal, would fall below the true horizontal diameter, and the measurements would be more in error than it would be with the points in any other direction. Still, if care is taken to preserve the points at the greatest length possible, a very tolerable degree of accuracy may be attained. In the inspection of guns arranged on skids, the gun itself should be turned, which will ensure accurate measurements. Care must also be taken not to allow the joints of the staff to become so loose that the coincidence of the centre line is destroyed when they are screwed together. If this should occur, however, a few turns of thread placed between them at the time of putting the instrument together would remedy the difficulty.

7th. *An instrument* for verifying the interior position of vents.

When the vent is drilled in the vertical plane of the axis, as in the guns of old patterns, a simple head, shaped to fit the bottom of the bore, or the chamber, with a staff fitted to it, is sufficient. But for the Dahlgren guns, with two vents, some other plan is better. The following has been found satisfactory:

A head of well seasoned wood, which is fitted to the chamber, is attached to a wooden disc of the diameter of the main bore. The surface of the head corresponds with a longitudinal, central section of the chamber; at the point where the projection of the vent would meet it a piece of hard wood is inserted. A central line drawn through its length, crossed at a right angle by another line at any known point from the smaller end, will afford convenient points to measure from. A stout square wooden staff is attached to the axis of the head; at a dis-

tance equal to the length of the bore, the end is jogged into the centre of a *half disc* of wood, which is fitted to the bore. The whole is so constructed that the straight edge of the half disc (or the chord) is in the same plane as a horizontal section of the head. A few holes are bored through the disc attached to the half head, to allow the instrument to pass freely into the gun and out of it.

A wire of untempered steel of the size of the vent, with a sharp well centred point, and a small *spirit level*, are required to use with this instrument.

The gun being levelled, and the instrument being pushed to the bottom of the bore, the upper edge of the half disc near the outer end of the staff is then brought to a level. The surface of the half head then corresponds with the horizontal central section of the chamber. The point of the wire being pushed gently to meet it, will show very accurately the interior position of the vent.

8th. *Profile boards* for distances in front and rear of the base line.

Their lower edges are adapted to the shape of the gun, and the upper ones are parallel to the axis of the bore.

The distances from the base line of the several parts, and of the points at which diameters are to be measured, are laid off accurately on the upper edge, and then marked in lines perpendicular to it on the sides and lower edges of the profile. A narrow strip is attached to the upper edge to prevent warping, and the whole is well coated with *shellac varnish* to keep it from absorbing moisture.

The following instruments are used in connexion with the profile boards:

A rule for verifying the marks, of such a length that not more than one fleeting may be necessary, to be graduated decimally according to the standard.

A small square of steel, to be used in referring the marks on the board to those on the rule.

A steel straight-edge, long enough to extend across the muzzle-face, and several inches on the board, to ascertain the extreme length from base to muzzle. It is also used for the same purpose at the extreme end of the cascable. A *steel scratcher*, to mark the gun at points not otherwise indicated, where diameters are to be measured.

9th. *A trunnion square* of steel or iron, for ascertaining the position of the trunnions, with reference to the axis of the bore. This instrument is *a square* with two branches, one of which is fixed and the other movable. The foot of each branch is in the same plane, and is parallel to the upper edge of the main piece which connects them. The latter is graduated to inches and tenths. The movable branch slides on the main piece, and may be secured to it by two thumb-screws. It is provided with a vernier scale graduated to hundredths of an inch. Between the branches there is *a slide*, also provided with a vernier graduated as before, with a thumb-screw to secure it firmly; in its centre there is a *sliding point*, moving vertically, with a thumb-screw to fasten it. Above the foot of each branch there is a slit to receive the shank of a plate, on the end of which a thread is cut; the lower edge of the plate forms a right angle with the branch, and the plate is fastened to the branch by a nut, at a point from the end equal to the semi-diameter of the trunnion, which is marked on each branch.

When the feet of the branches, or the lower edge of the plates, rest upon the trunnions, the upper edge of tho main piece is parallel to their axis, if their alignment is correct. When in the latter position, the edges of the feet will lie close against the sides of the trunnions.

A graduated steel wedge is used to measure the deviation of the trunnions from the feet of the square.

10th. *A trunnion gauge*, which is an iron ring of the proper diameter of the trunnions. Its outer edge coincides with the diameter of the rimbases.

11th. *A trunnion rule* to measure the distance of the trunnions from the base ring, or line. This is an *iron rod* with a head at one end, through which passes one branch of a small *square*. The centre of the rod is marked on the end, and the square is set so that the inner edge of the branch which is parallel to tho rod is at a distanco equal to the semi-diamcter of the trunnion from the centre. It is secured in this position by screws and clamps.

The upper side of the rod is graduated to inches and tenths. *A slide* with a slot through it, to show the graduation beneath, traverses upon it, and is kept from turning by a guide on the lower side. There is a vernier upon the slide graduated to hundredths of an inch; a thumb-screw serves to secure the slide at any point on the rod. That end of the slide from which the graduation of the rod commences has both of its sides drawn out to form knife edges; the knifo edges and the end of tho slide are in the same plane. When the square at the end is placed on the trunnion, the end of the rod will touch its side at tho point of its greatest diameter. The rod being held parallol to the axis of tho bore, with the side of the head pressing the rimbase, the knife edge will be in a proper position to fall into the base line when moved to find it.

12th. *A beam calliper* for measuring diameters is a *square* of steel or iron, with two branches, one of which is fixed and the other sliding. The inner edges of the two branches, when pushed together, lio, of course, in contact with each other throughout their length. The beam is graduated to inches and tenths. A vernier is attached to the sliding branch, graduated to hundredths of an inch. The latter is provided with a thumb-screw to fasten it at any point.

The length of the beam must be rather greater than the diameter; and that of the branches than the semi-diameter of the guns to be inspected, at their largest points.

13th. *A cascable block* is a wooden cylinder of the proper diameter of the breeching hole, the size of which is used to verify.

The opening between the jaws may be ascertained by measuring the iron block, which is fitted to go between them, or by a template.

14th. *A vent guide*, to be used with vents in guns of Dahlgren's pattern.

This instrument is made of bronze or composition. When placed upon the gun, one of its branches coincides with the curve of the cylinder, and the other, starting from its centre, lies along the cylinder in contact with it longitudinally. The lower edges of the branches are a right line and a curved line, making two right angles with each other. The length of that of the transversc branch is equal to the distance between the centre of the two vents. The rear surface of the transverse branch is curved and quadrilateral. Its sidos are inclined, so

that their rear edges shew the exact direction of the vents. Every point in the upper edge lies in the same horizontal plane. The height is sufficient to permit the edges to give an accurate direction to the drill.

The upper edge of the other branch runs off in a sloping curve to its extremity.

A centre line is drawn through the lower edge of the longitudinal branch, and is continued upwards on the rear surface of the transverse branch to the top.

The guide being placed with its centre upon the centre mark of the gun, and the centre line of the longitudinal branch being made to coincide with the centre line scribed upon the cylinder, the rear lower edge of the transverse branch will then coincide with the base line, its extremities will indicate the centres of the vents, and the rear edges of the sides will shew their true direction.

15th. *Vent gauges* of untempered steel wire, with shoulders to prevent them from slipping into the vent. One should be of the proper diameter of the vent, one of the greatest, and one of the least diameter allowed.

16th. *A vent searcher*, a steel wire of the length of the vent, bent to a right angle at the lower end and pointed. It is used for detecting imperfections in the sides of the vents.

17th. *A semicircular protractor* of metal for measuring the inclination of vents, or for ascertaining their deviation from the guide.

18th. *A set of templates* for verifying the shape of lock-lugs, the angle of the rear sight mass, the curve between the base line and the front of rear sight mass, that at the end of the cascable, the bevel of the breeching hole, the opening of the cascable, the shape of the muzzle swell, &c.

If the inspection should take place at the foundry, the templates used in chipping might be verified and used for inspection.

For guns of Dahlgren's pattern, a bronze model, showing the shape of the lugs and rear sight mass, and the position of the vents, has been furnished as a guide to the contractors.

19th. *A standard foot-rule* for verifying measures.

20th. *A foot-rule of steel* for measuring the masses, the length of the trunnions, and for other purposes. The graduation should be extended to each end.

21st. *A set of ring gauges*, large, medium, and small, for inspecting the projectiles used in proof.

22d. *A small beam calliper*, with outside edges, for examining the adjusting rings and the ring gauges.

23d. *A platform balance* for weighing the projectiles used in proof, and for bringing the shells up to the standard weight. For use with the above there should be provided a *bag of dry sand*, *a funnel*, some *wooden plugs* for the fuze holes, and a *hammer*.

24th. *A set of implements* for loading and cleaning, viz:

A rammer, faced with hard wood or metal, with a graduated scale on the staff, near the muzzle, to show the distance of the front of the projectiles from the muzzle.

A bristle sponge with a worm in its end, for ordinary use in firing.

A sheepskin sponge, for drying the bore after cleaning it.

A gun scraper.

A ladle.

A boring bit.

A priming wire.

A lock and laniard, should navy primers be used in firing; but if friction primers are used, then a laniard with a hook in its end will be required, only.

A breeching and a couple of tackles, if the guns should be fired on skids.

Six handspikes.

Six buckets and a large tub, for washing out the guns.

And if the firing is made into a butt, then a couple of wheelbarrows, with two or three pickaxes, and half a dozen shovels, will be necessary.

25th. *A searcher*, with six or more points, to detect injuries or cavities in the bore.

26th. A machine for taking the interior impression of vents.

This consists of a wooden *head*, one-half of which is cylindrical, and the other half is of the shape of the chamber, both being rather smaller than the parts of the bore that they are intended for. A *staff*, flat on its upper side, and rounded on its under side to fit the curve of the bore, is mortised into the circumference of the cylindrical part of the head. A mortise is cut through the chamber part of the head, extending several inches in rear and front of the position of the vent. Into this mortise a loose piece is fitted, capable of free motion upwards and downwards, the top of which is fitted with holes to secure the wax or composition which is spread over its surface. This *movable piece* rests on a wedge attached to a flat rod running through a slot in the head; there is a slot in this rod about four inches long, a pin passing through it into the staff. *To use the instrument*, withdraw the rod as far as the slot will permit, which will allow the movable piece on which the composition has been spread, to drop below the surface of the head, and protect it. Push the head to the bottom of the chamber, and arrange the position of the staff so that the movable piece will cover the vent, then press the end of the rod home. This motion will throw out the composition, and a distinct impression of the vent and of fire cracks, (should there be any,) will be left upon its surface; draw the rod back as far as the slot will allow, and withdraw the instrument: the impression, being protected thereby, will come out uninjured.

Impressions of injuries or cavities in the bore may easily be taken by a similar contrivance.

27th. *Hydraulic pump and apparatus* for the water-proof.

Any of the various patterns of this machine may be applied to the proof of guns. An iron cross-head is secured to a stout wooden block which fits into the muzzle, and which has a flange or shoulder to cover the muzzle-face; rings of caoutchouc or gutta-percha are placed between them; an iron rod with a ring in one end, to fit over the trunnion, and with a thread cut on the other end, is used on each side of the gun, to connect the trunnion with the cross-head. The whole is set up with nuts, and the pressure upon the rings makes a tight joint; a coupling upon the cross-head receives the hose, and the water is forced into the gun through a hole in the wooden block. Care should be taken that the valve is loaded with the proper weight for proof.

28th. *Dies for marking guns.* A full set of figures, with such capital letters as may be required for the inspection marks; these should be one inch in length. Also, small letters o suitable size to mark "lbs.," and a full set of half-inch figures.

USE OF THE INSPECTING INSTRUMENTS.

The guns having been freed from rust, and their foundry numbers noted, in the order of their relative positions, on the field-book, the inspecting officer will proceed to verify the instruments to be used in their measurement, if this has not been previously done in a manner entirely satisfactory to him.

He will then examine carefully the guns, inside and out, for defects of metal or of manufacture, and note the results.

The interior of the bore is to be examined by reflecting the rays of the sun into it from a mirror or mirrors; or, if the sun is obscured *and there can be no delay*, by means of a spirit-lamp, or of a wax taper, on the end of a rod, taking care not to smoke the surface of the bore.

The *cylinder gauge* is then to be introduced, which must pass freely to the bottom of the cylindrical part of the bore. If obstructed, the depth to which it reaches should be noted.

The *star gauge* is used to ascertain the exact diameter of the bore, and of the cylindrical part of the chamber. The bore must be measured at intervals of ¼ inch from the bottom of the cylindrical part to the seat of the shot; of 1 inch from that point to the trunnions; and of 5 inches from the trunnions to the muzzle. If any marks of the reamer or other defects are seen in the bore, they are to be searched for, and their depths and positions noted. These results are to be tabulated according to the blank forms furnished. The whole *length of the bore* is ascertained by means of the measuring staff, with the point screwed on, supported in the axis of the bore by the *discs* and *half-tompion.*

In the absence of this instrument, a *pine rod*, having the proper length of the bore marked on it, and the end rounded to the curve of the bottom of the bore, will answer as well, using a thread or a straight-edge across the face of the muzzle.

The *shape* and *dimensions* of the *chamber*, and the *position* of the interior *orifice* of the *vent*, are verified by means of the *chamber gauge*, the description of which will explain its use. An inspection of the chamber reamer will be generally satisfactory in determining the size and shape of the chamber.

The *vent is measured* by the appropriate gauges, the smaller of which must enter freely, and the larger not at all. It is searched for roughness or for cavities in the metal around it, by means of the *searcher*, the point of which should feel every part of it carefully.

Its inclination to the surface, and its position externally, is verified by means of the *vent-guide* furnished for the Dahlgren guns, and by the semicircular protractor and the vent-gauge.

In guns of the ordinary construction the position of the vent is marked on the profile board, and its inclination to the surface is determined by the protractor and vent-gauge.

The *exterior lengths* of the gun are measured by the profile board, marked with the true dimensions, the differences being measured by the foot-rule, or, if minute, estimated by the eye.

The *exterior diameters* are measured with the callipers and square, or by the set-gauges used in turning, and a graduated wedge.

To verify the *position* and *alignment* of the trunnions of a gun, it is first necessary to ascer-

tain, by means of the trunnion gauge and of the callipers, their cylindrical form and their diameters, which should be the same, or allowance must be made for half the difference in measuring their axial distances from the base line, by the trunnion rule, which should next be done. These distances should be equal, or their axes do not coincide—an error not tolerated.

The trunnion square is then placed upon the trunnions in the plane of their axis. The feet of its branches should coincide with the surfaces of both trunnions, throughout their length, above and in rear, and their inner edges with the faces of the rimbases. Then, with the beam compass, scribe on the upper surface of the gun the distance of the axis of the trunnions from the base line, and push the sliding point of the square down, till, at that distance, it touches the surface of the gun, and screw it fast. Then turn the gun over, and again scribe on it the same distance from the base line. The square being again applied, will determine whether the trunnions are above or below the axis of the bore, which will coincide with that of the gun, if accurately bored and turned on the same centres and bearings. If the branches rest upon the trunnions before the point of the slider touches the gun at the scribe, their axis is below; but if the point touch first, above the axis of the bore, by half the space between. The *graduated wedge* being placed under the vertical sliding point will determine the amount. If both touch at once, both axes are in the same plane.

No gun can be received, the axis of the trunnions of which is *above* that of the bore.

The lengths of the trunnions are measured with the foot-rule, and the diameters of the rimbases by that of the exterior rim of the trunnion gauge.

If the *alignment* of the trunnions be correct, it will serve as a means of determining the correctness of the *line of sight*, which, before the gun is removed from the lathe, should be distinctly traced on the sight-masses and the swell of the muzzle, and should be at right angles to the base line, to the axes of the trunnions, and to the connecting piece of the trunnion square, when its branches rest against their rear, with the plates across their upper surfaces.

The Inspector will further satisfy himself of the correct tracing of the line of sight on the gun by examining the lathe and the manner of tracing it in the plane of the axis of the bore, at right angles to the axis of the trunnions, as by it are placed the sights and vent, and in their absence it serves as a line of metal sight.

The positions of the *sight-masses* are verified by the profile board, and by reference to the line of sight, traced on them; their form and dimensions by the *templates.*

The *positions* of the *lock-lugs* and their *forms* are verified by means of the bronze pattern furnished to each foundry for each class of the Dahlgren guns, and their dimensions by the templates. For other guns the position of the lock-piece is marked on the profile board, and their measures taken as above.

The *opening* of the *cascable* and its curves, and those of the breech and the muzzle-swell, are verified by means of the "*cylinder block*" and the templates.

The following variations from the proper dimensions may be *tolerated* by the Inspector, though every effort should be made to conform exactly to the drafts furnished by the Bureau of Ordnance.

			Inch.
In the diameter of the bore	more		0.03
	less		0.00
Exterior diameter	where turned or planed	more	.05
		less	.05
	where not turned or planed	more	.20
		less	.05
In the length	of the bore, more or less		.10
	from rear of base ring or line to face of the muzzle, more or less		.25
	of the cascable, from rear of base ring to the end, more or less		.20
	of the reinforce, more or less		.15
From the axis of trunnions to base line, more or less			.05
In the length of chamber, more or less			.10
In the position of the axis of the trunnions	above axis of the bore		.00
	below axis of the bore		.20
In the length of trunnions, more or less			.05
Diameter of trunnions, less			0.25
In the same gun, no variations to be tolerated in the position of the trunnions, or in their alignment.			
In the vent	diameter more		0.025
	do. less		.000
In lock piece any dimensions	more		.10
	less		.00
Variation of position of exterior orifice of vent			.05
Idem of interior do. do			.20
Depth of cavities	in the bore or vent		.00
	on exterior surface of reinforces, where turned or planed		.10
	elsewhere, where turned or planed		.25
	on trunnions, within one inch of rimbases		.10
	on trunnions, elsewhere		.25
Enlargement or indentation of bore by proof, not to exceed			.02

The measures are to be taken by scales corresponding with the standard measures of the United States.

If two or more cavities should be near each other on the exterior, the gun may be rejected, though the cavities should be of less depth than tolerated in the table.

If the trunnions are placed within the limits of toleration, the preponderance must not vary more than 5 per cent., more or less, from that fixed in the contract.

POWDER-PROOF.

The proof charges shall be as follows:

	Calibre and class of gun.	Charge of powder.	Projectile.	Wads.	Number of fires.
		Pounds.			
Shell guns.	XV-inch .... 43,000 lbs.	~~50~~	~~Cored shot~~	~~Sabotted~~	~~1~~
		~~35~~	~~Shell~~	....	~~10~~
	XI-inch .... 16,000 lbs.	25	Solid shot	Gromet	1
		15	Shell	....	10
	X-inch .... 12,500 lbs.	18	Solid shot	Gromet	1
		12	Shell	....	10
	IX-inch .... 9,000 lbs.	15	Solid shot	Gromet	1
		10	Shell	....	10
	8-inch of 63 cwt., or .... 7,000 lbs.	12	Shot	Gromet	1
		10	Shell	....	10
	8-inch of 55 cwt., or .... 6,000 lbs.	10	Shot	Gromet	1
	8" 4650 lbs (new)	8	Shell	....	10
Shot guns.	130-pdr. of — cwt., or .... 16,000 lbs.	30	1 shot	Gromet	10
	64-pdr. of 106 cwt., or .... 12,000 lbs.	20	....do	....do	10
	32-pdr. of 57 cwt., or .... 6,400 lbs.	15	....do	....do	10
	32-pdr. of 51 cwt., or .... 5,700 lbs.	13	....do	....do	10
	32-pdr. of 42 cwt., or .... 4,700 lbs.	10	....do	....do	10
	32-pdr. of 33 cwt., or .... 3,600 lbs.	10	....do	....do	10
	32-pdr. of 27 cwt., or .... 3,000 lbs.	9	....do	....do	10
	32 4500 lbs (new) ———	8	"	"	10

The cannon powder for proof shall be of not less than 1,500 feet initial velocity, as determined by the gun pendulum at the Ordnance yard, Washington.

It shall be filled in service cylinders, and well settled.

For chambered pieces the increased charges should fill the chamber and necessary portion of the bore.

The projectiles shall be of full weight, and not below the mean gauge; the shell shall be filled with a mixture of sand and ashes to bring them up to the proper weight of the filled shell.

Sabots for the shell and a gromet wad over the shot.

The gun should be fired on skids or a proving carriage, to test the trunnions.

If five per cent. out of any lot offered for ordinary proof under a contract shall fail to sustain it, the whole may be rejected, as may be stipulated in the contract.

WATER-PROOF.

The pressure to be applied in the water-proof will be two atmospheres, or thirty pounds to the square inch.

The penetration of water in this proof through the metal of the piece, in any place, will cause the rejection of the gun; and if, on examination after the water-proof, there shall be any defects indicated by weeping or dampness in the bore, the gun shall be rejected.

The water-proof is alone to be depended on to detect minute clusters of cavities in the bore, which, for this purpose, should be perfectly dry, and examined by sunlight. All inspec-

* Modified by Bureau Order of Octr 3d 1863, to –

3 Pounds Cannon Powder ...

tions, consequently, should take place in fair weather, and when the temperature is above the freezing point.

MARKING GUNS.

Guns for the naval service, received by authority of the Bureau of Ordnance, are to be marked in the following manner, viz:

On the cylinder, in the line of sight near the sight mass, all accepted guns are to have (two) stamped an anchor ~~three~~ (2) inches long.

Drawings of these stamps will be furnished by the Bureau of Ordnance.

On the base ring or line, the initials of the foundry, the register number, and the weight of gun in pounds.

On the right trunnion, the calibre and year of fabrication.

On the left trunnion, the letter P. and the initials of the inspecting officer; all the above in one-inch letters.

On the upper jaw of the cascable, the preponderance in pounds to be stamped lightly with *half-inch* figures.

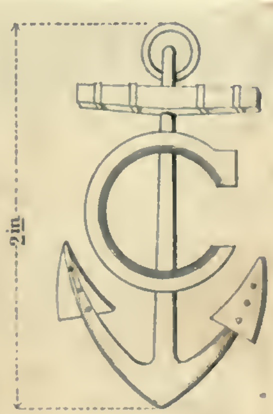
On the end of the upper jaw, the cascable block and head of the pin, the foundry number in *quarter-inch* figures.

The foundry number is also to be marked on the right rimbase.

Guns rejected for imperfections of any kind will have the letter C stamped on the anchor, so as to partially obliterate it.

The founders are to be dissuaded from selling such guns to other parties, and required to break them up.

Guns rejected for such defects as render them dangerous to those who fire them should be *irreparably mutilated*, with the consent of the founder.



Note — On all approved Naval Guns, the Anchor alone is to be stamped on the cylinder near the reinforce sight-mass, in the line of sight.

—— When the Gun is condemned, the letter C is to be stamped on, as above

EXTREME PROOF OF TRIAL GUNS.

The extreme proof of guns intended for trial of metal, subject to such modifications by the Bureau as future experience may dictate, will be conducted as follows:

A suitable "butt" shall be erected to arrest the flight of the projectile used in proof, and to admit of their easy recovery, and a bomb-proof, readily accessible, for the protection of the firing party.

When practicable the "butt" should be made thick enough to allow the shot to just pass through, and be stopped by another beyond it, without penetrating the latter; this is, for XI-inch, about 12 feet.

With care, it is estimated that 130 shells may be fired 1,000 times, at the rate of one hundred rounds per day.

After undergoing the ordinary proof established for its calibre and class, the gun selected for extreme proof shall be subjected to at least 1,000 rounds with service charges.

It may be fired from the skids, or suspended, as the Bureau may direct.

During the trial the gun shall be frequently and critically examined inside and out for cracks or defects, especially about the interior orifice of the vent, of which impressions are to be taken in wax at regular intervals in the manner prescribed on page 26, or in such other manner as the Bureau may direct. If they show that the vent is corroded in furrows, and enlarged considerably in diameter at its junction with the bore, a permanent impression is to be taken in lead to show the conical enlargement. The following manner, practiced at the Experimental Battery at Washington, is recommended:

IMPLEMENTS REQUIRED.

1. *A soft wire* about 0.07 in. diameter, and 3 or 4 fathoms long.

2. *A lever* about twice the length of the bore, and about 3 inches in diameter, and shod to suit the curve of the bore nearly.

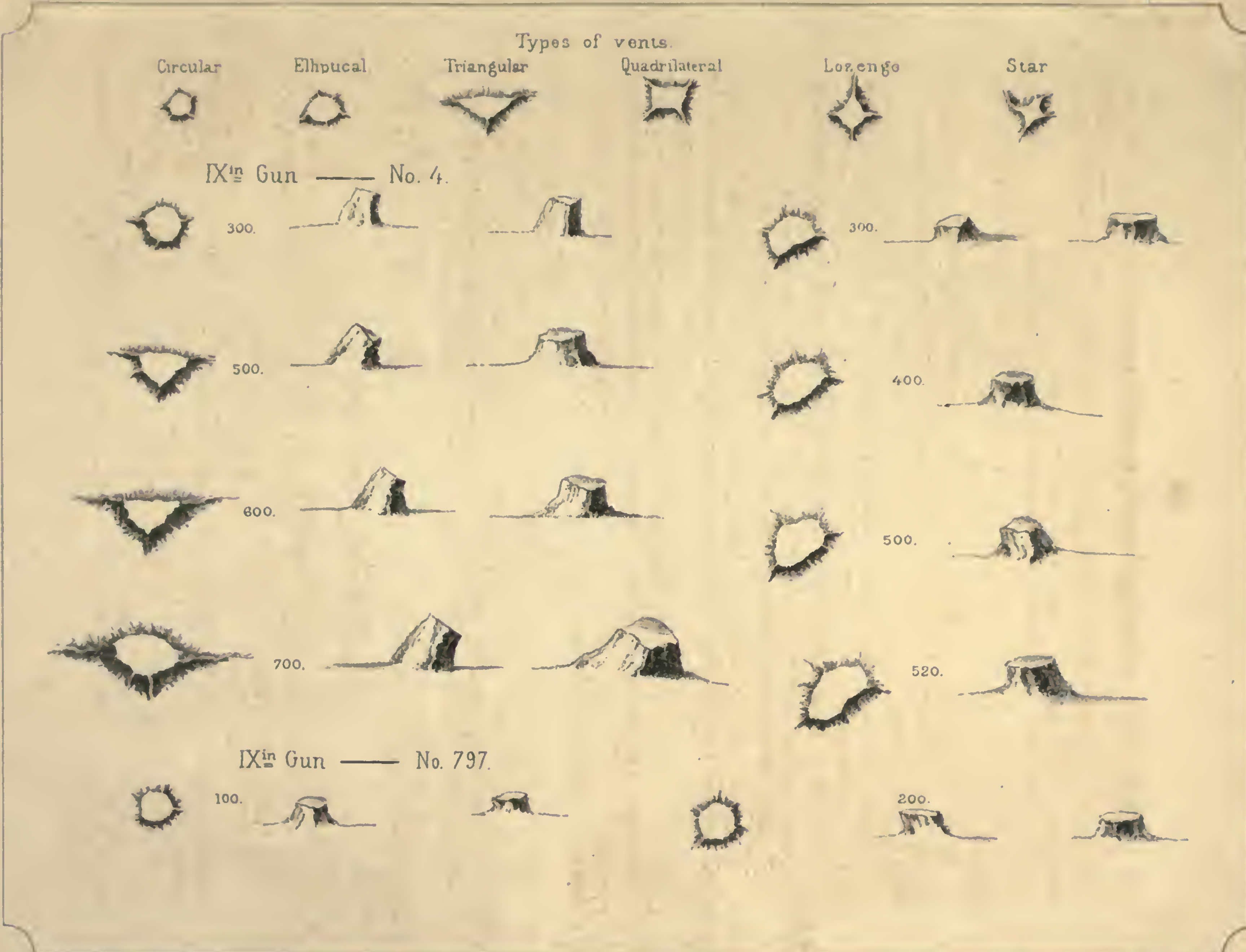
3. *A small button of soft lead*, judged to be of sufficient size to fill the vent at least one inch from the bore. This is to be pierced lengthwise to receive the wire.

TO TAKE THE IMPRESSION.

Shove the wire through the vent; let it pass along the bore and out at the muzzle; put it through the leaden button and tie a knot at the end. Draw the wire back through the vent until the leaden button is introduced firmly into the inner orifice.

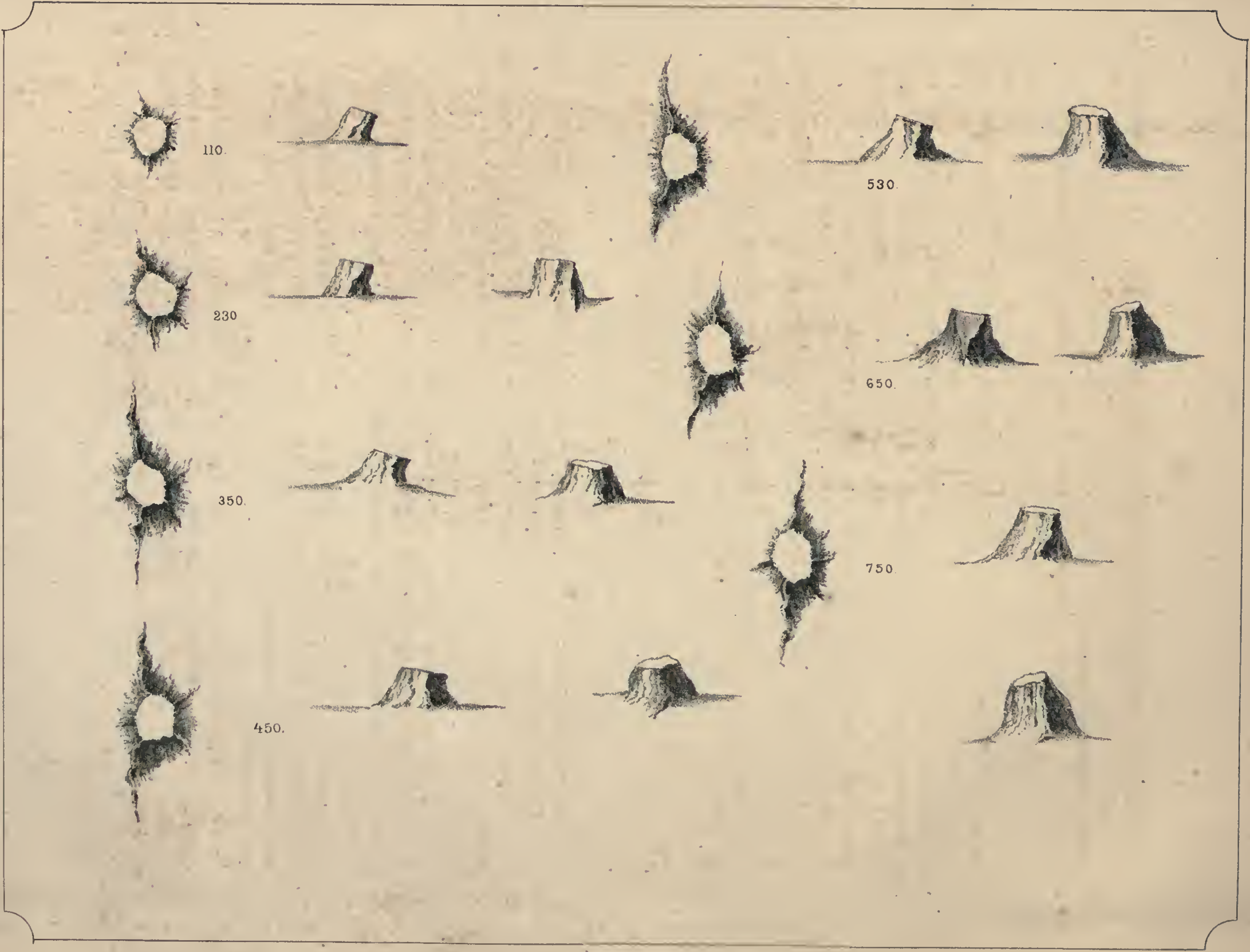
Apply the lever, making its shoe bear on the button, and force it well in by repeated blows, the muzzle being the fulcrum. This done, disengage the button by pushing in the priming-wire.

In taking impressions of the vent and cracks, each button in turn is used as a pattern for moulding its succsssor, allowing for the progressive enlargement of the vent, or the cracks emanating from it. When the crack shows itself, the head of the button should be so enlarged as to include it.



Types of vents.
Circular
Elliptical
Triangular
Quadrilateral
Lozenge
Star
IXin Gun —— No. 4.
300.
500.
600.
700.
300.
400.
500.
520.
IXin Gun —— No. 797.
100.
200.

XI $\frac{\text{in}}{=}$ Gun No. 897.



These examinations should take place after every twenty fires, at least, and more frequently when any unusual enlargement of the vent or extension of cracks shall be developed and indicate its speedy destruction.

Before each examination the bore of the gun is to be carefully washed and dried.

In recording the measurements of the bore in extreme proof and after service, distinguish between "indentation," which is the depression at the "seat of the shot," which is always below, and the "wear of the bore," which is generally above, and increase of bore or "enlargement" from any other cause.

When from the appearance of the bore at the interior orifice of the vent, and especially when a crack or cracks appear to be extending rapidly, the vent so enlarged may be filled with melted tin, zinc, or Babbitt metal; a tight-fitting sponge head being pushed to the bottom of the chamber to close the interior orifice, and the other vent be drilled through for the purpose of continuing the firing.

The precise time at which this is to be done will vary, according to circumstances; such as quality of metal, charge, and elevation.

The endurance of a gun with service charges may be surely predicted by observation of the progressive wear of the interior orifice of the vent.

There are certain general forms in which this enlargement takes place. They may be classed as triangular, lozenge, quadrilateral, star, circular, and elliptic. (See plate.)

With the ordinary central vent, when subjected to a rapid, continuous fire, the enlargement usually takes the form of an isosceles triangle, the apex of one of the angles towards the muzzle, and the other two perpendicular to it.

With the lateral vent of the Dahlgren system it usually takes the lozenge form, the cracks extending from the opposite angles lengthwise of the bore.

With those rifled cannon in which the vent is bouched, the cracks appear around the bouching, and although the bouching preserves the vent, yet the formation of fissures around the enlarged orifice when once commenced causes a greater tendency to rupture. With the vent not bouched, the wear in rifled cannon is about double that of the smooth bore.

So long as the wear of the vent is regular and without cracks, a mere enlargement is not indicative of danger; but when it reaches a diameter of four-tenths (.4) of an inch the vent should be closed and a new one opened.

A gun of large calibre should not *in service* be expected to endure more than 400 or 500 rounds before it will be necessary to open the new vent, which, however, will be of no advantage, unless the old one be closed at its *interior* orifice, on which the gases would otherwise continue to act as a wedge.

The first distinct appearance of the cracks, as shown by the button, is the proper limit.

After the gun bursts, make a sketch or draft showing lines of fracture, and reserve specimens to be sent to the Ordnance yard at Washington for trial of density and tensile strength; and if practicable, a photograph should be taken.

PREPARATION OF GUNS FOR SERVICE.

After the guns have been received at the navy yards it is necessary to adjust the sights, and, in the guns of the Dahlgren pattern, cut the screw hole in the cascable.

CUTTING THE SCREW HOLE.

The boring and screw-cutting machine is a convenient portable hand drill-press, the use of which is readily understood by any machinist.

The gun being carefully levelled and the trunnions placed horizontal, the position of the centre of the screw hole, which in the guns of the Dahlgren pattern is tangent to the radius of the breech, is marked on the neck of the cascable with a centre punch.

The machine is placed on the cascable, the boring shaft inserted in the hollow leading bar, and its movable centre placed on the mark. The instrument is then set vertical, by a spirit level on the cogged driving wheel and the four pairs of set screws on the clamp-head embracing the cascable.

The centre is then removed and a drill inserted in the lower extremity of the boring shaft, which, being held firmly by a shoulder and turned by a four-armed wrench, while pressed up to the metal by slowly turning the cogged driving wheel, cuts the hole. This is successively enlarged, by two or more counterbits, to the size of the body of the screw.

The cutter is then inserted in the leading bar, and the thread cut.

ADJUSTMENT OF THE SIGHTS.

The bore having been thoroughly cleaned, the axis is levelled by a spirit level; this may be very conveniently done by the aid of the levelling bar. The axis of the trunnions is to be placed horizontal, either by placing a small level on the trunnions, or, as more exact, by using the trunnion square. If the trunnion square is used it will be proper to verify the position of the line of sight, which is frequently incorrectly placed at the foundries.

The breech sight is then to be adjusted.

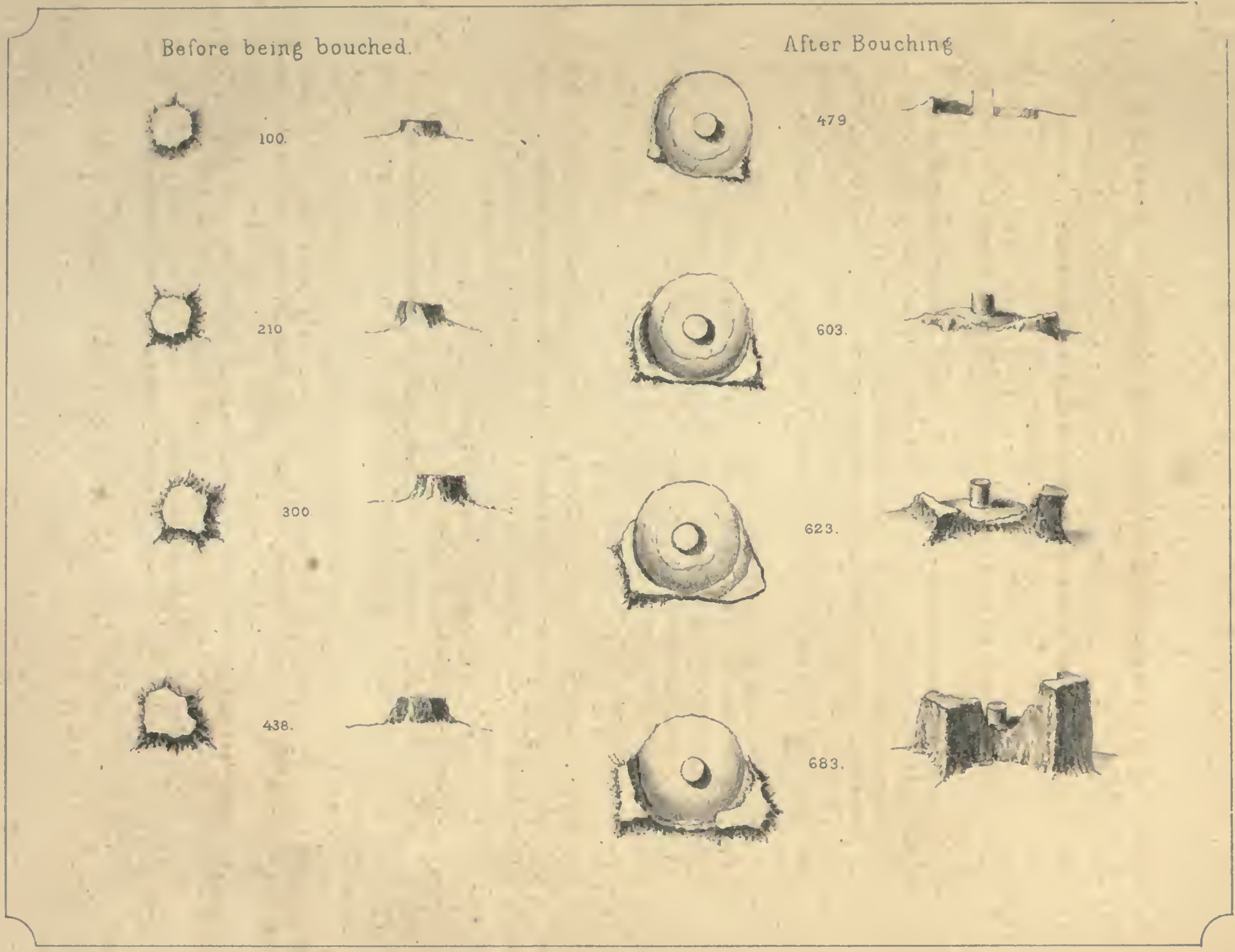
A brass head or tompion, fitted with a vertical arm, on which there is a ledge for a spirit level, is then introduced into the bore, and the arm placed vertical by the spirit level and a tangent screw.

The arm is pierced on its centre line with two holes—one at the height of the prescribed diameter of the muzzle, the other at a height equal to the proper distance of the bottom of the sight notch from the axis of the bore. A waxed thread or fine wire being stretched from the upper hole to the centre of the sight notch will coincide with the line of sight traced on the swell of the muzzle, the top of the reinforce sight mass, and the base line, if they are correctly placed. It will also be parallel to the axis of the bore if the adjustment of the breech sight is exact, and the top of the reinforce sight is made to coincide with it.

This is, however, seldom the case, and after the adjustment of the reinforce sight it is necessary to verify it.

This is done by the levelling bar—a square steel bar with parallel faces, somewhat longer

50 Pdr No. 44.


Before being bouched.
After Bouching
100.
210
300
438.
479
603.
623.
683.

than the distance between the sights, the rear end of which is bevelled at 60°, (the angle at which the sight is placed.)

The outer end of this bar is placed on the reinforce sight, which has been previously adjusted to the proper height, and the bevelled end in contact with the outer face of the sight bar. The bar is then levelled by two screws placed near the inner end, and a spirit level on its upper surface.

If then the bottom of the sight notch coincides with the bottom of the bar, the line of sight is parallel to the axis; otherwise, the reinforce sight or the sight bar must be lowered until coincidence is obtained.

A centre line on the bar verifies the coincidence of the line of sight, and also the motion of the sight bar in the vertical plane. The bevel verifies the angle of the bar, and the distance between the outer faces of the sight notch and of the reinforce sight being also marked on the levelling bar, verifies this adjustment.

Another method is sometimes and more advantageously used in adjusting the sights of guns which have not been turned.

~~Two iron or wooden discs are turned to the exact diameter of the bore, and placed on a rod two or three feet longer than the bore. One of the discs is placed near the bottom of the bore, the other just within the muzzle. On the part projecting beyond the muzzle, there is a double square, each arm of which is divided into equal parts and traversed by a fine slit.~~

~~The square being set vertical by a spirit level or plumb line, and a waxed thread or wire stretched taut from the outer arm through the slit, cutting equal divisions on each and passing through the centre of the slit, it is evident that a line of sight is obtained through the centre of metal and parallel to the axis of the bore.~~

~~This method has the advantage of adjusting the sights in any plane parallel to the axis, as in the case of the side sights of rifled and other cannon.~~

Ordered to be stricken out
Dec 1865

ADJUSTMENT OF THE SIDE SIGHTS.

The gun having been levelled, and the trunnions placed horizontal, a centre line is to be drawn on the top of the left (or right) rimbase.

The support for the sight is then to be fitted to the breech, at the distance from this line marked on the pattern sight for its calibre, with the bottom of the sight notch in the bar, exactly the height of the front sight (one inch) above the upper surface of the rimbase; the sight bar perpendicular.

It is advisable to place a very thin sheet of rubber under the support to prevent the heads of the screws from being jumped off by the vibration. The screws have the same thread as those for the present reinforce sight.

After the breech sight is adjusted a parallel to the axis of the bore is to be drawn in the usual manner, and the front sight screwed in on the rimbase.

Some trifling adjustment may then be required to bring the height of the top of the front sight and the bottom of the sight notch parallel to the axis of the bore in both the horizontal and vertical planes.

REPORT.—Form (1.)

Note.—The Proof Gun is to be entered at head of each page in red ink.

NO.	CHARGE OF FURNACE, IN POUNDS.										NO.

NO.	CHARGE OF FURNACE, IN POUNDS.					NO.
				Total in Pounds.		

NO.	COMBINATION OF METAL, PER CENTUM.							FURNACE.	FUEL.	BLAST.	NO.

NO.	DATE OF CASTING.	TIME.				NO.
		REQUIRED TO OBTAIN COMPLETE FUSION.	KEPT IN FUSION.	OF FILLING MOULD.	REMAINED IN OPEN PIT.	

Sketch always to be sent, showing the *exact* places from whence specimens are taken.

NO.	MEAN DENSITY AND TENSILE STRENGTH OF 3 SPECIMENS.								NO.
	AT FOUNDRY.				AT WASHINGTON.				
	DENSITY.		TENSILE STRENGTH.		DENSITY.		TENSILE STRENGTH.		
	Head.	Core.	Head.	Core.	Head.	Core.	Head.	Core.	

NO.	EXCESS OF ROUGH OVER FINISHED DIMENSIONS.						GUN HEADS.			TIME OF BORING.	TIME OF TURNING.	NO.
	K. Excess at Muzzle-face.	H. J. Excess at Chase.	G. Excess at 3d Curve.	E. Excess at 2d Curve.	C. Excess at 1st Curve.	A. Excess at Breech and Cylinder.	LENGTH.	DIAMETER.				
							Inches.	Inches.	Inches.			

NO.	METAL WORKED.		CAVITIES, &c.	NO.
	At Foundry.	At Washington.		

NO.	APPEARANCE AT FOUNDRY OF—				NO.
	FRACTURE OF CORE.	CORE.	BORE.	EXTERIOR SURFACE.	

NO.	WEIGHT OF GUN.	PREPONDERANCE.	DISTANCE FROM BASE-RING TO CENTRE OF TRUNNIONS.		MAXIMUM INDENTATION BY POWDER PROOF.	DIAMETER OF BORE BY STAR GAUGE, AFTER PROOF.		NO.
	POUNDS.	POUNDS.	INCHES.		1000THS OF AN INCH.	GREATEST.	LEAST.	
			Right.	Left.				

NO.				NAME OF INSPECTOR.	ARE THE INSPECTOR'S MEASUREMENTS WITHIN REGULATION LIMITS?	NO.

NO.		REGISTER. NO.	REMARKS.	NO.

REPORT.—(Form 2.)

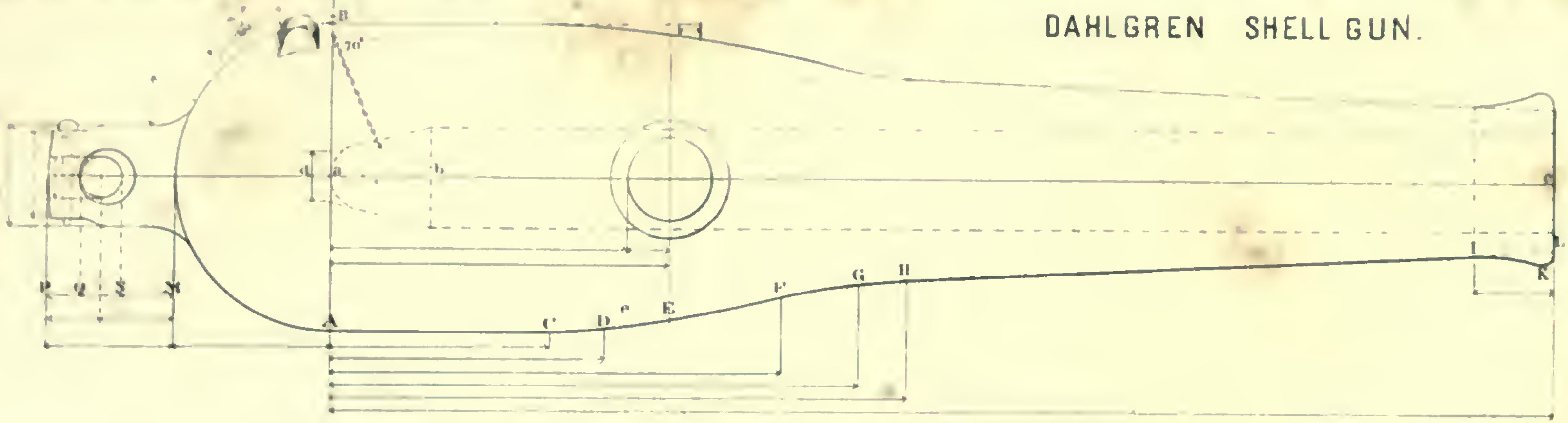
Dimensions of ——— guns cast at the ——— Foundry of ———, 18 .

CLASS.	LENGTHS FROM A, THE BASE, TO ——.											
inch. lbs.	B.	C.	D.	e.	E. Left.	E. Right.	F.	G.	H.	I.	K.	L.
Prescribed dimensions.												
Foundry No.												

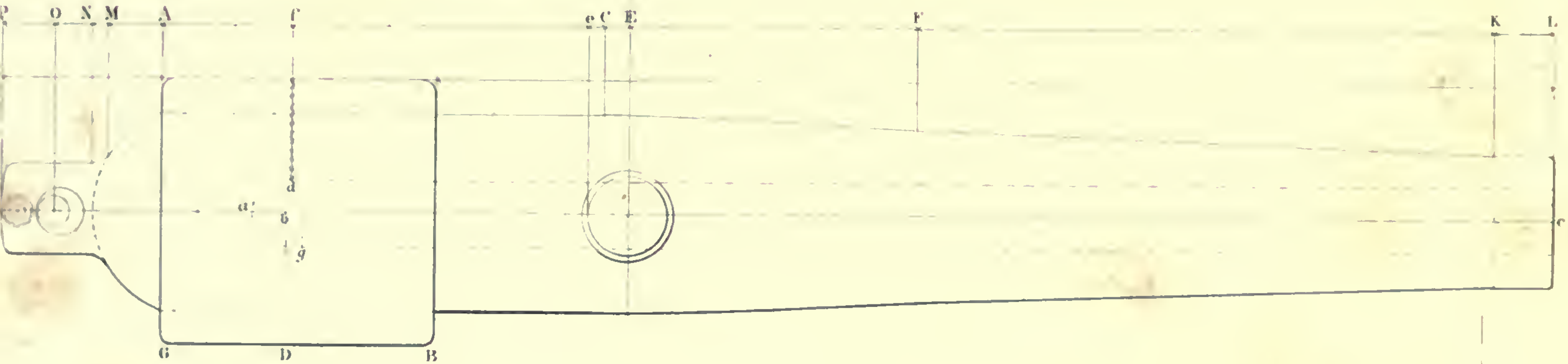
	DIAMETER AT ——.										
	A.	C.	D.	E. Gun.	E. Rimbases.	F.	G.	H.	I.	K.	L.
Prescribed dimensions.											
Foundry No.											

	MISCELLANEOUS.										
	Lengths. Bore. a c.	Lengths. Chamber. a b.	Diameter of bore.	Error of chamber.	Weight of Gun. Lbs.		Preponderance at base.	Density of metal.	Tenacity of metal.	Int. of vent. dist'ce from a.	Int. of vent. dist'ce from axis.
Prescribed dimensions.											
Foundry No.											

DAHLGREN SHELL GUN.



PARROTT RIFLE GUN - 1864.



C. forward of trunnions on VIII ins.

C to K is straight on VIII. ins.

F to K. is straight on other Guns

REPORT.—(Form 2)—Continued.

(SEE DIAGRAM.)

M.	N.	O.	P.	Length of trunnions.					Remarks.
				Left.	Right.				
									Cylinder gauge descends.

(SEE DIAGRAM.)

M.	N.	O.	P.	Trunnions.		Rimbases.		Trunnions below axis	
				Left.	Right.	Left.	Right.		

Charges of powder, lbs.		Powder, by whom made, and date of manufacture.		Initial velocity of powder, feet.		Weight of projectile, lbs.			

REPORT.—(Form 3.)

The excess over prescribed diameter of bore before and after proof, as found by the star gauge, at different

der (inches from face) to seat of shot; thence at every ~~two~~ inch~~es~~ to trunnions, (

searched for and recorded, with its distance from face; thus—

Calibre and No. of Gun.															
inch B. P. Foundry No. A. P.															
inch B. P. Foundry No. A. P.															
inch B. P. Foundry No. A. P.															
inch B. P. Founfiry No. A. P.															
inch B. P. Foundry No. A. P.															
inch B. P. Foundry No. A. P.															

REPORT.—(FORM 3—Continued.

distances from the muzzle, to be taken at every ¼ inch from the bottom of the cylin-
inches from the face;) thence every five inches. The greatest enlargement to be

															Front of shot from face of muzzle.	Greatest diameter after proof in rear of trunnions or near seat of shot.	Diameter at same before proof.	Enlargement.